TECHNICAL MEMORANDUM

TO: Dennis Crumpler / OAQPS
FROM: Eric Boswell / NAREL
COPY: Michael Werst / CARB
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DATE: January 4, 2012
SUBJECT: CARB Laboratory Audit

Introduction

On September 15, 2011, a Technical Systems Audit (TSA) was conducted at the Northern Laboratory Branch of the California Air Resources Board (CARB) facilities located in Sacramento. The TSA was conducted as part of the US EPA's quality assurance oversight for the $PM_{2.5}$ Chemical Speciation Network (CSN). CARB has elected to use their own laboratory facilities to analyze many of the speciation samples collected within the state rather than use other laboratories which are available to perform this function under a federal contract.

This audit was performed by Steve Taylor and Jewell Smiley from EPA's National Air and Radiation Environmental Laboratory (NAREL) located in Montgomery, AL. This TSA was a routine inspection of specific laboratory systems and operations at CARB that are required for the analysis of $PM_{2.5}$ Speciation samples. The last TSA performed by NAREL was conducted in September of 2008 [see reference 1].

Summary of Audit Proceedings

This audit required a significant amount of advanced planning and communication before the auditors actually traveled to CARB. A preliminary agenda was prepared and distributed so that CARB staff would be available for interviews and would also be available to participate in several experimental activities planned for the audit.

The first item on the agenda was a brief meeting with laboratory supervisors and staff at which time the audit team gave an overview of the audit process. The agenda included inspection of the following operational areas.

- ✓ Sample Receiving and Handling – Michelle Fristoe and Brenda Saldana
- ✓ Ion Chromatography (IC) Analysis – Samantha Scola and Michelle Fristoe
- ✓ X-Ray Fluorescence (XRF) Analysis – Mike Humenny
- ✓ Gravimetric Mass Analysis – Michelle Fristoe and Brenda Saldana
- ✓ Carbon by Thermal Optical Analysis (TOA) – Peter Samra

Besides the areas mentioned above, the following CARB staff were also available to assist and participate in the audit.

- ✓ Michael Werst – Inorganic Laboratory Section Manager
- ✓ Dan Tackett – LIMS Specialist

Several experimental activities were on the agenda which were discussed with CARB staff during the briefing. Blind samples had been prepared at NAREL for each analytical area and brought to the audit so that analysts could be observed performing the analysis and results could be compared to expected values. The details of these experiments will be described later within the appropriate section of this report.

CARB's Northern Laboratory Branch provides a large number of chemical analyses using many different analytical methods. However, this TSA focused exclusively on the techniques listed above which are used to analyze $PM_{2.5}$ filter samples collected at seven speciation sites and thirty additional sites that monitor the gravimetric mass only. All seven speciation field sites are currently equipped with a pair of collocated Met One SASS and URG 3000N air samplers. The Met One unit is used for collecting $PM_{2.5}$ onto Teflon® and Nylon® filters. The URG unit is used for collecting $PM_{2.5}$ onto a quartz fiber filter so that subsequent OC/EC analysis can be performed. CARB has been analyzing speciation samples since January of 2002.

The auditors were familiar with CARB's Standard Operating Procedures (SOPs) for the areas inspected. A few months before the TSA was scheduled, a set of single-blind Performance Testing (PT) samples were prepared at NAREL and submitted to CARB for analysis. All of the results from these PT samples were available for discussion with CARB staff during the audit [see reference 2].

Sample Receiving and Handling

The laboratory is responsible for shipping clean filters to the field sites and receiving the loaded (exposed) filters back at the lab. Samantha Scola, Michelle Fristoe, and Brenda Saldana were available to explain the laboratory procedures for preparing filters for shipment and maintaining proper custody of samples received back into the lab. An SOP is posted on the web that describes this critical process [see reference 3].

Sample receiving and handing was the first area inspected, and both auditors were present to observe how filters were received and processed through the lab. New clean filters are prepared for shipment to the supported field sites by placing the new Teflon® and Nylon® filters into SASS canisters, and the new quartz filters are first placed into cassettes which are then assembled into URG 3000N cartridges. Each new filter has a significant level of protection to minimize any unwanted contamination during shipment and at the field site. After the sampling event, the loaded filters are returned to the laboratory still mounted in the canisters and the cartridge, and are cooled to approximately 4 °C during transit. Upon receipt at the lab, the samples are removed from the shipping cooler, and the temperature is recorded. The canisters and cartridge are disassembled, and each recovered filter is placed into a new container. The Teflon® and the quartz filters are transferred to labeled Petri slides, and the Nylon® filter is transferred to a labeled extraction tube. Canisters and filter holder cassettes must be cleaned before they are used again. A dishwasher was used to clean these items.

CARB maintains a stock of ready-to-go filters, and during the audit, a request was made to remove two of each filter type from the laboratory stock. These six stock filters were carried back to NAREL for analysis, and the results from NAREL's analysis are presented in table 1.

Table 1. Results from Clean Filters Removed from CARB's Stock

Filter ID	Filter Description	Parameter	Instrument	Concentration (µg/filter)
Q11-14109	Quartz test filter #1	Elemental Carbon	Carbon Anal.	not detected
Q11-14110	Quartz test filter #2	Elemental Carbon	Carbon Anal.	not detected
Q11-14109	Quartz test filter #1	Organic Carbon	Carbon Anal.	5.8
Q11-14110	Quartz test filter #2	Organic Carbon	Carbon Anal.	1.5
N11-14111	Nylon® test filter #1	Nitrate	IC	0.5
N11-14112	Nylon® test filter #2	Nitrate	IC	0.2
N11-14111	Nylon® test filter #1	Sulfate	IC	0.2
N11-14112	Nylon® test filter #2	Sulfate	IC	0.3
N11-14111	Nylon® test filter #1	Ammonium	IC	not detected
N11-14112	Nylon® test filter #2	Ammonium	IC	not detected
N11-14111	Nylon® test filter #1	Potassium	IC	not detected
N11-14112	Nylon® test filter #2	Potassium	IC	not detected
N11-14111	Nylon® test filter #1	Sodium	IC	0.3
N11-14112	Nylon® test filter #2	Sodium	IC	0.3
T11-14113	Teflon® (CARB# PFS0528)	PM2.5 Mass	Balance	-1*
T11-14114	Teflon® (CARB# PFS0527)	PM2.5 Mass	Balance	1*

Pre-mass determined at CARB and Post-mass determined at NAREL.

No significant contamination was observed on the filters taken from CARB's stock. Please note that XRF analysis was not performed on the Teflon® filters listed in table 1. Also note that the $PM_{2.5}$ mass concentration was determined by using the pre-mass value determined routinely at CARB and the post-mass value determined a few days later at NAREL.

Field blanks are used to monitor for accidental contamination of the filter media. A request was made to query the Laboratory Information Management System (LIMS) for recent field blank results. Field blank results from calendar year 2010 were examined, and a summary of those results is presented in table 2.

Table 2. Summary of Field Blank Results for Calendar Year 2010

		Concentration (µg/filter)					Number of
Parameter	Instrument	Average	Max	Min	Std. Dev.	LOD*	Values
$PM_{2.5}$ Mass	Balance	8.3	28	-6	6.73	1	41
Ammonium	IC	0.04	0.15	0.00	0.042	0.5	42
Nitrate	IC	0.56	1.19	0.25	0.204	0.5	40
Potassium	IC	0.02	0.11	0.00	0.030	1.25	42
Sodium	IC	0.08	0.20	0.00	0.042	0.75	42
Sulfate	IC	0.13	1.23	0.00	0.235	1.75	42
Total Carbon	Carbon Anal. – 3000N	3.9	9.2	1.8	1.75	9	42

Parameter	Instrument	Concentration (µg/filter)					Number of Values
		Average	Max	Min	Std. Dev.	LOD*	
EC by TOR	Carbon Anal. – 3000N	0.0	0.9	0.0	0.16	9	42
EC by TOT	Carbon Anal. – 3000N	0.0	0.0	0.0	0.00	9	42
OC by TOR	Carbon Anal. – 3000N	3.9	8.9	1.8	1.65	9	42
OC by TOT	Carbon Anal. – 3000N	3.9	9.2	1.8	1.75	9	42
PyrolC by TOR	Carbon Anal. – 3000N	0.0	0.0	0.0	0.00	-----	42
PyrolC by TOT	Carbon Anal. – 3000N	0.0	0.9	0.0	0.16	-----	42
EC1	Carbon Anal. – 3000N	0.0	0.4	0.0	0.09	-----	42
EC2	Carbon Anal. – 3000N	0.0	0.4	0.0	0.07	-----	42
EC3	Carbon Anal. – 3000N	0.0	0.0	0.0	0.00	-----	42
OC1	Carbon Anal. – 3000N	0.2	1.3	0.0	0.32	-----	42
OC2	Carbon Anal. – 3000N	1.4	2.7	0.7	0.53	-----	42
OC3	Carbon Anal. – 3000N	2.1	4.6	0.8	0.90	-----	42
OC4	Carbon Anal. – 3000N	0.1	1.3	0.0	0.27	-----	42
Aluminum	XRF	-0.31	-0.10	-0.45	0.086	0.2	42
Antimony	XRF	0.07	0.25	0.00	0.072	0.2	42
Arsenic	XRF	0.00	0.01	0.00	0.002	0.02	42
Barium	XRF	0.10	0.13	0.07	0.014	0.2	42
Bromine	XRF	0.00	0.01	0.00	0.002	0.02	42
Calcium	XRF	0.05	0.40	0.01	0.059	0.06	42
Chlorine	XRF	0.03	0.13	0.01	0.025	0.06	42
Chromium	XRF	0.00	0.02	0.00	0.005	0.03	42
Cobalt	XRF	0.00	0.01	0.00	0.002	0.03	42
Copper	XRF	0.02	0.04	0.00	0.008	0.04	42
Iron	XRF	0.04	0.21	0.02	0.031	0.04	42
Lead	XRF	0.00	0.02	0.00	0.005	0.03	42
Manganese	XRF	0.00	0.01	0.00	0.004	0.03	42
Mercury	XRF	0.00	0.01	0.00	0.004	0.03	42
Molybdenum	XRF	0.00	0.00	0.00	0.000	0.06	42
Nickel	XRF	0.00	0.01	0.00	0.003	0.03	42
Phosphorus	XRF	0.00	0.01	0.00	0.002	0.04	42
Potassium	XRF	0.06	0.16	0.03	0.025	0.07	42
Rubidium	XRF	0.00	0.01	0.00	0.003	0.02	42
Selenium	XRF	0.00	0.01	0.00	0.003	0.02	42
Silicon	XRF	0.09	0.81	0.00	0.150	0.06	42
Strontium	XRF	0.01	0.02	0.00	0.006	0.03	42
Sulfur	XRF	0.01	0.07	0.00	0.014	0.05	42
Tin	XRF	0.05	0.27	0.00	0.058	0.2	42
Titanium	XRF	0.01	0.07	0.00	0.013	0.04	42
Vanadium	XRF	0.00	0.01	0.00	0.005	0.03	42
Yttrium	XRF	0.00	0.01	0.00	0.004	0.03	42
Zinc	XRF	0.01	0.07	0.00	0.013	0.02	42

LOD = Limit of Detection

Table 2 contains the average, maximum, minimum, and standard deviation of field blank results, and also contains CARB's estimated limit of detection for most of the speciation parameters.

Good laboratory practices were generally observed for supplying clean filters to the supported field sites and for retrieving the loaded filters following sample collection. No deficiencies were noted for this area of laboratory operations.

Ion Chromatography (IC) Laboratory

Samantha Scola and Michelle Fristoe escorted the auditors to the IC laboratory where they were both available to answer questions about the analysis of ions. CARB's SOP for the analysis of ions is available for public viewing [see reference 4].

The laboratory is equipped with an automated Dionex 2000 instrument running Chromeleon® software. One channel is optimized for the analysis of anions, and another channel is optimized for the analysis of cations. Extractions are performed with deionized water using an ultrasonic bath and a shaker table. Nine standards are routinely used to develop calibration curves and establish retention times.

Michelle was given the opportunity to analyze an unknown solution during the audit. The auditors had brought two solutions with them to be analyzed during the audit. Michelle was advised to dilute each solution by a factor of ten before her analysis, and she should use her own pipets, containers, and the local reagent water to perform the dilution. She was given the unknown solutions during the initial briefing so there was plenty of time to perform her analysis. Results are presented in table 3, and all of the results are excellent.

Table 3. Demonstration of Anion and Cation Analysis During the Audit

Sample ID	Sample Description	Parameter	Expected Value (ppm)	CARB Result (ppm)
SS11-14101	Anion solution provided by NAREL	Fluoride	1.00	not reported
		Chloride	1.00	not reported
		Nitrite	1.00	not reported
		Nitrate	2.00	1.95
		Sulfate	2.00	1.96
SS11-14102	Cation solution provided by NAREL	Lithium	0.25	not reported
		Sodium	1.00	0.98
		Ammonium	2.00	1.94
		Potassium	1.00	1.00
		Magnesium	1.00	not reported
		Calcium	5.00	not reported

Michelle was also asked to give the auditors some of her mid-level calibration solutions so that they could be analyzed at NAREL for an independent assessment of accuracy. The results from NAREL's analysis are shown in table 4, and all of the results show reasonably good agreement with the expected values provided by CARB.

Table 4. CARB Calibration Standards Analyzed at NAREL After the Audit

Sample_ID	Sample Description	Parameter	Expected Value (ppm)	NAREL Result (ppm)
SS11-14103	Anion standard provided by CARB	Nitrate	1.44	1.53
		Sulfate	0.60	0.63
SS11-14104	Cation standard provided by CARB	Sodium	0.22	0.21
		Ammonium	0.22	0.21
		Potassium	0.19	0.20

Good laboratory practices and good documentation were in place for the analysis of ions by IC. Based upon these observations and results from these experiments, the IC lab is in good shape.

X-Ray Fluorescence (XRF) Analysis Laboratory

Mike Humenny is responsible for performing the XRF analysis. He was available to answer questions about his analysis. Mike normally reports the twenty-eight elements identified earlier in table 2 of this report. The latest version of his SOP is available on the web [see reference 5].

After the exposed Teflon® filters have been weighed to determine the PM2.5 gravimetric mass, the filter samples are made available for the XRF analysis. Mike uses a QuanX EC instrument available from the Thermo Electron Corporation. The instrument uses a liquid nitrogen cooled silicon detector, and it has been set up to routinely acquire four spectra from which the analytical results are derived. The instrument conditions are listed in table 5.

Table 5. XRF Analysis at the CARB Laboratory

Instrument: Thermo QuanX EC	**Software: WinTrace 3.0.2**			
	Instrument Conditions for Routine Sample Analysis			
Parameter	**#1**	**#2**	**#3**	**#4**
X-ray tube parameters:				
Tube voltage (kV)	10	30	50	50
Tube current (mA)	1.98	1.66	1.00	1.00
Tube anode material	rhodium	rhodium	rhodium	rhodium
Direct excitation of sample:				
Filter Material	cellulose	palladium	palladium	copper
Filter thickness (mm)	unknown	0.025 mm	0.125 mm	0.377 mm
Acquisition time (seconds)	800	400	400	800
Energy range acquired (keV)	0-10	0-20	0-40	0-40
Number of [MCA] channels	512	1024	2048	2048
Sample rotation (yes/no)	yes	yes	yes	yes
Beam spot size, diameter (mm)	unknown	unknown	unknown	unknown
Atmosphere (vacuum, He, air)	vacuum	vacuum	vacuum	vacuum
Elements Reported	Al Si P S Cl K Ca	Ti V Cr Mn Fe Co Ni Ba	Cu Zn As Se Br Rb Sr Y Mo Hg Pb	Sn Sb

The auditors had brought a filter sample for Mike to analyze during the audit. However, Mike did not have time to complete the analysis before he was scheduled to leave work at noon. Mike was able to perform the analysis after the audit and report his results to the auditors at that time. Those results are presented in figure 1 along with results from a previous analysis also performed at CARB.

Figure 1. Test Filter Previously Analyzed at CARB

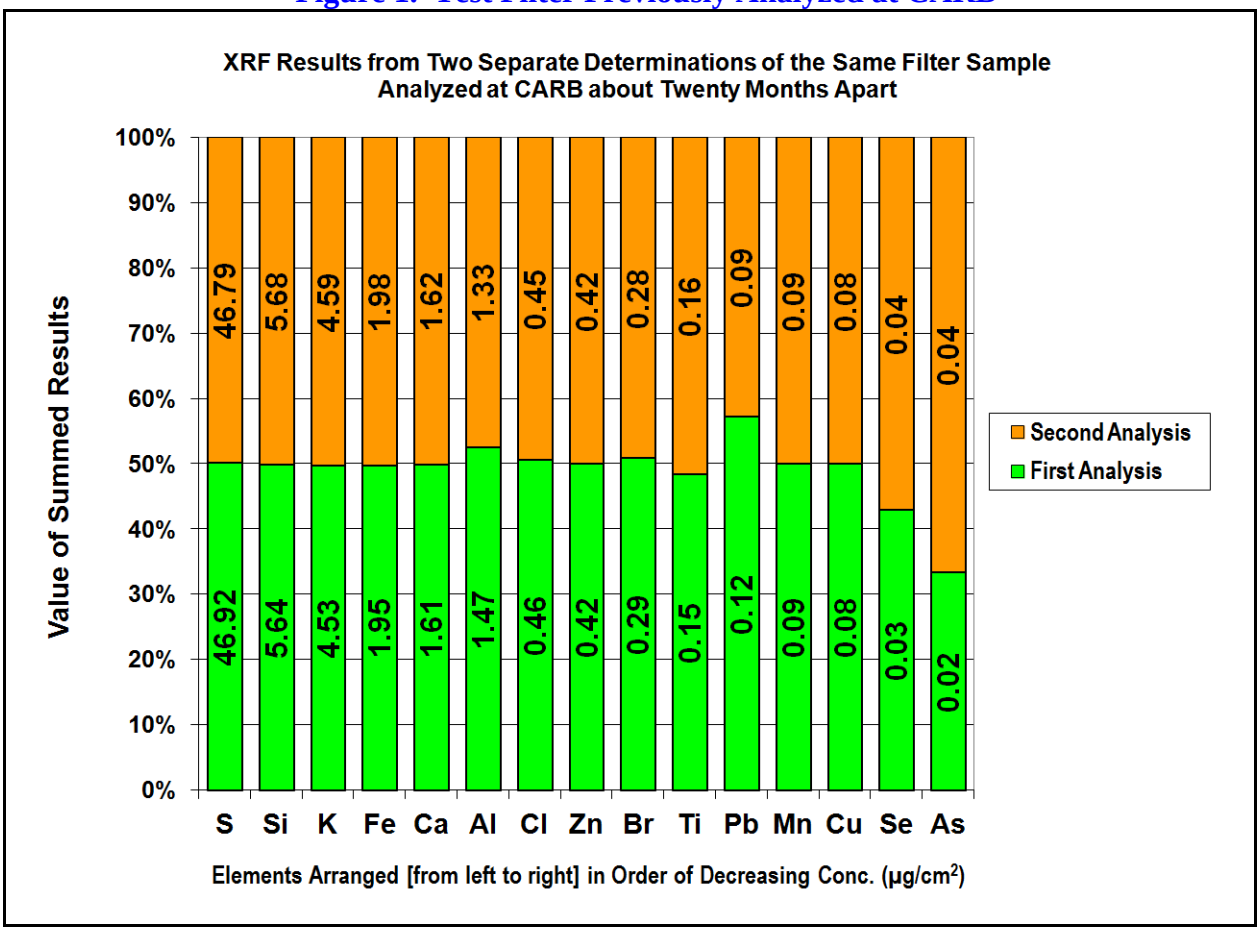

Figure 1 is a normalized stack-bar graph showing two sets of results from the same filter sample. The first analysis was performed at CARB and reported to NAREL as part of EPA's annual inter-laboratory study. The second analysis was scheduled for the on-site audit, and Mike was not told that he had analyzed this filter previously. Figure 1 shows remarkable agreement between the first and second analysis. No negative findings were observed for the XRF operations.

Gravimetric Laboratory

Samantha Scola, Michelle Fristoe, and Brenda Saldana escorted the auditors to the gravimetric weighing chamber. The weighing lab is a dedicated room with controlled temperature, humidity, and dust. Chamber blanks which are left open inside the room are routinely analyzed to monitor dust. Two Dickson data loggers were brought to the audit and placed near CARB's temperature and humidity sensors located inside the weighing room. The temperature and humidity inside the weighing chamber are routinely recorded onto a rotating disk shown in Figure 2. Good agreement was observed between measurements recorded on the local chart and the independent Dickson data loggers.

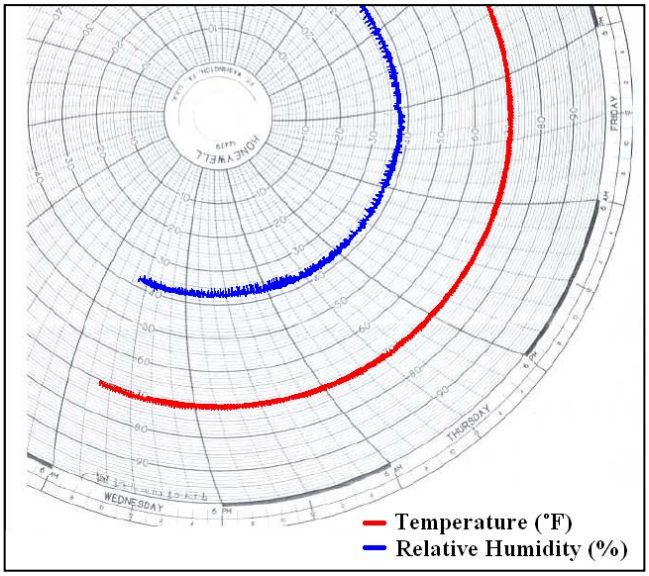

Figure 2

Prior to the audit, the auditors had planned for experimental demonstrations that could be performed by CARB analysts. In preparation for the gravimetric demonstrations, two Teflon® filters were inspected, equilibrated in NAREL's weighing chamber, and then weighed to determine the conventional mass of each filter. Two stainless steel mass standards that had been slightly altered from their nominal mass were also weighed at NAREL. All four samples were placed into individual labeled Petri slides and brought to the TSA where they were used to demonstrate CARB's weighing procedures in the gravimetric lab.

Michelle and Brenda were both familiar with CARB's SOP for weighing filters [see reference 6], and they were ready to start the gravimetric demonstration once the auditors arrived at the weighing lab. The filters and metallic weights had been placed in the weighing room with the Petri slides open to facilitate sample equilibration. Brenda started the weighing session using a Mettler Toledo XP6 microbalance. The session not only included the two filters and two metallic weights provided by NAREL, but also included two fully equilibrated filters provided by CARB and two filters randomly selected by the auditors from CARB's stock of filters. Table 6 shows results from the gravimetric demonstration expressed as conventional mass (displayed by the balance) and also expressed as true mass that includes a correction for the buoyant lifting force acting on an object weighed in air.

Table 6. Results from Gravimetric Demonstration

Sample ID	Sample Description	Conventional Mass (mg)			True Mass (mg)		
		NAREL	CARB	Difference	NAREL	CARB	Difference
MW11-14095	Metallic weight provided by NAREL	193.821	193.822	0.001	193.821	193.822	0.001
MW11-14096	Metallic weight provided by NAREL	92.959	92.958	-0.001	92.959	92.958	-0.001
T11-14097	Teflon® filter provided by NAREL	146.280	146.283	0.003	146.409	146.412	0.003
T11-14098	Teflon® filter provided by NAREL	143.529	143.531	0.002	143.655	143.658	0.003

Sample ID	Sample Description	Conventional Mass (mg)			True Mass (mg)		
		NAREL	CARB	Difference	NAREL	CARB	Difference
T11-14099	Equilibrated Teflon® filter provided by CARB	143.680*	143.682	0.002	143.807	143.809	0.002
T11-14100	Equilibrated Teflon® filter provided by CARB	140.964*	140.962	-0.002	141.089	141.086	-0.003
T11-14113	Teflon® filter removed from CARB stock	144.941*	144.942	0.001	145.069	145.070	0.001
T11-14114	Teflon® filter removed from CARB stock	142.564*	142.563	-0.001	142.690	142.689	-0.001

This value was determined at NAREL a few days after the audit.

Modern microbalances are programmed to display "conventional mass", not the "true mass" described by Newton's second law of motion. All of the conventional mass values in table 6 were taken directly from the balance display. Table 6 also shows the [true] mass of each sample which was calculated using the following equation [see reference 7 and 8].

$$m_x = m_c \times (1 - \rho_{air}/\rho_{std}) \div (1 - \rho_{air}/\rho_x) \qquad \textbf{Equation 1}$$

where

m_x is the [true] mass of the sample
m_c is the conventional mass indicated by the balance display
ρ_{air} is the air density
ρ_{std} is the density of the balance calibration standard, 8 g/cm^3
ρ_x is the density of the sample

Although some of the samples were allowed only a few minutes to equilibrate, the corrected [true] mass values in table 6 show good agreement between CARB and NAREL for all of the samples. The [true] mass values are sometimes needed for an on-site audit especially when the test lab is at a different elevation compared to NAREL's location at 300 feet above sea level. When the test lab is at a significantly higher elevation, the air density is less resulting in less buoyant lifting force operating on objects that displace air. Teflon® filters are significantly less dense than the stainless steel weights used to establish the balance calibration curve. The "true mass" shown in table 6 is the balance reading corrected to account for any significant difference in the buoyant lifting force at two locations, NAREL and CARB. Since the density of the metallic samples (MW11-14095 and MW11-14096) is essentially the same as the balance calibration weights, the displayed conventional and [true] masses are equal (see equation 1). It should be stated that even though a calculated [true] mass may be needed for some audits to compare the filter mass determined at NAREL with the filter mass determined at the test lab, [true] mass values are not required for routine $PM_{2.5}$ determinations. Measuring the pre-weight and post-weight of a filter on the same balance at the same location eliminates the need for a buoyancy correction.

Good laboratory practices and good documentation were in place for the gravimetric weighing laboratory. The weighing experiments produced very good results. No negative findings were observed.

Carbon by Thermal Optical Analysis (TOA)

Peter Samra is responsible for the analysis of quartz fiber filters to determine the organic carbon (OC) and elemental carbon (EC) fractions present in the sample. He uses a DRI Model 2001 instrument and routinely runs the IMPROVE_A thermal optical method to analyze samples. His SOP is available on CARB's web site [see reference 9].

New filters are pre-fired for four hours in a furnace at 900 °C before they are ready to send to field sites for sampling. Even though the quartz filters are easily contaminated with OC, table 2 shows a low-level of contamination for the field blanks.

The instrument is calibrated at least every six months using multiple levels and multiple sources of carbon. An instrument blank and a NIST-traceable calibration check is performed daily before samples are analyzed. An automatic injection of methane gas is performed at the end of every sample analysis to serve as an internal standard.

During the briefing at the beginning of the audit, Peter was given two blind samples with a request to analyze them at his earliest convenience. The samples had been prepared at NAREL and brought to the audit. One sample was prepared from a thermally cleaned quartz fiber filter from which several circular 0.5 cm^2 subsamples were removed using a punch tool and placed into a labeled Petri dish with a tight fitting lid. A second sample was prepared exactly like the first except that each subsample was spiked with 20 µg (40 µg/cm^2) of carbon from a sucrose solution that was allowed to air dry in a separate labeled Petri dish. Except for the labels, the two samples were visibly indistinguishable. The results from CARB's analysis are presented in table 7 along with spike levels and results from the independent analyses performed at NAREL.

Table 7. Demonstration of Carbon Analysis

Sample ID	Sample Description	Carbon Fraction	Spike Level (µg/cm^2)	CARB Result (µg/cm^2)	NAREL Result (µg/cm^2)
Q11-14106	Blank Quartz	OC	0.00	1.02	0.75 ± 0.24
		EC	0.00	ND	0.00 ± 0.20
Q11-14107	Spiked Quartz	OC	40.0	41.38	40.03 ± 2.2
		EC	0.00	ND	0.00 ± 0.20

Table 7 shows good agreement between labs. Sucrose was selected for the spike material because it chars readily during the analysis, like many ambient air samples, and it offers a good challenge for how well the analysis can distinguish the OC and EC originally present in the sample.

Travel blanks were brought to the audit and were not opened before they were carried back to NAREL for analysis. Experience has shown that travel blanks can be very useful for those audits that include demonstration blanks. The results from two quartz travel blanks are shown in table 8.

Table 8. Trip Blanks and Calibration Standard Analyzed at NAREL

Sample ID	Sample Description	Carbon Fraction	Spike Level (µg/cm^2)	NAREL Post-Audit Result (µg/cm^2)
Q11-14089	Quartz Travel Blank #1	OC	0.00	0.32 ± 0.22
		EC	0.00	0.00 ± 0.20
Q11-14090	Quartz Travel Blank #2	OC	0.00	0.16 ± 0.21
		EC	0.00	0.00 ± 0.20
SS11-14108	KHP Calibration Check Solution provided by CARB	OC	36.0	36.5 ± 2.1
		EC	0.00	0.10 ± 0.20

Table 8 also contains results from a calibration check solution provided by CARB. Peter was asked to give the auditors some of his daily KHP (potassium hydrogen phthalate) solution so that it could be analyzed at NAREL. According to NAREL's analysis, the KHP solution was very accurate.

Good laboratory practices and good record keeping were observed in the carbon analysis laboratory. No deficiencies were observed for this area of operations.

Other Staff Interviews

Cindy Castronovo is currently the Northern Laboratory Branch Chief. She spoke only briefly with the auditors and promptly turned them over to Michael and his team since all of the $PM_{2.5}$ analyses are performed within the Inorganic Section labs. Dan Tackett is familiar with the Laboratory Information Management System (LIMS), and he was able to provide the auditors with the historical data that were requested during the audit. He provided the field blank data summarized in table 2 of this report.

Conclusions

The auditors are pleased to report that no significant technical problems were found during the audit. This audit included several experimental activities which add to the objectiveness of the visit. Virtually all of the observations made during the audit were positive. Sincere thanks to everyone who participated in this TSA!

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